I. REMARKS

The Office Action dated February 16, 2010, has been received and carefully noted. The above amendments to the specification, drawings, and claims, and the following remarks, are submitted as a full and complete response thereto.

By this Response, Figures 2 and 3 and the specification at page 8, lines 15 and 16 have been amended to overcome the objections to the drawings. Claims 26, 28, and 36 have been amended to more particularly point out and distinctly claim the subject matter of the invention. No new matter has been added. Support for the above amendments is provided in the specification, at least, on page 9, line 15, to page 20, line 10. Accordingly, claims 21, 23-28, 30-33, 36-38, 40-42, and 46-47 are currently pending in the application, of which claims 21, 32, and 38 are independent claims. Applicants request entry of the above amendments because the above amendments place the figures, the specification, and the claims in better condition for issuance.

Applicants thank the Examiner for indicating that embodiments of the invention contain allowable subject matter as illustrated in Figures 2 and 3 (*see* Office Action on pages 10-12). Applicants further thank the Examiner for proposing amendments to claim 21.

In view of the above amendments and the following remarks, Applicants respectfully request reconsideration and timely withdrawal of the pending rejections to the claims for the reasons discussed below.

(A) ***Drawing Objections under 37 C.F.R. §1.83(a)***

The drawings were objected to under 37 C.F.R. §1.83(a) because Figure 3 allegedly fails to illustrate a signal input to the "joint optimizer," as described in the specification on page 8, lines 15-16. The Office Action alleged that Figure 3 is a block diagram of a portion of the receiving station that forms part of the system shown in Figure 1. The Office Action further alleged that, since Figure 3 is a block diagram of a receiving portion of Figure 1, it is allegedly not clear how the optimizer 74 shown in Figure 3 is to be connected to existing component(s) of Figure 1 to receive it's input. The Office Action recommended amending the specification to recite, "Figure 3 illustrates the functional block diagram of the joint optimizer, prefilter and decision feedback sequence estimator shown in Fig. 3" (*see* Office Action on pages 2 and 3).

Accordingly, Applicants have amended the specification at page 8, lines 15 and 16, as recommended in the Office Action.

The Office Action also objected to the drawings because there is allegedly no support in the specification for the drawings, as amended in Applicants' Response filed December 30, 2009. Specifically, the Office Action alleged that the description of Figure 1 does not support the inclusion of a circuit block of "prefilter and feedback filter coefficients calculator." Further, with respect to Figure 2, the Office Action alleged that the input signal 53, input to joint optimizer 74, is not supported by the original disclosure, and therefore should be deleted. The Office Action further alleged that the output of prefilter 56 should feed the DFSE 58, and the DFSE 58 should include an output line.

Further, with respect to Figure 3, the Office Action alleged that the input signal 53 to joint optimizer 74 should be removed as the optimizer is described to only receive estimates.

Applicants respectfully traverse the objection to the drawing for Figure 1. Applicants respectfully submit that one of ordinary skill in the relevant art would have understood that coefficients of the prefilter 56 and the DFSE 58 would have to have been calculated for the prefilter 56 and the DFSE 58 to function. One would have further understood that the calculation of the coefficients of the prefilter 56 and the DFSE 58 occur in the joint optimizer 74, which has been replaced in Figure 1 with the "Prefilter Feedback Filter Coefficients Calculator." Support for these calculations are provided in the specification, at least, on page 17, line 7, to page 18, line 16. Accordingly, sufficient support is provided in Applicants' specification to enable one of ordinary skill in the relevant art to make and/or use the "Prefilter Feedback Filter Coefficients Calculator," as illustrated in Figure 1.

Applicants respectfully traverse the objections to the drawings for Figures 2 and 3 related to the input signal 53 input into the joint optimizer 74. Applicants respectfully submit that one of ordinary skill in the relevant art would have understood, from Applicants' specification, at least, on page 17, line 7, to page 18, line 16, that the input signal 53, which is the signal vector y_K, is input into the joint optimizer 74, because it's included in the equation on page 17, line 17, of Applicants' specification. Accordingly, sufficient support is provided in Applicants' specification to enable one of ordinary skill

in the relevant art to make and/or use the input signal 53 that is input into the joint optimizer 74," as illustrated in Figures 2 and 3.

As recommended in the Office Action, Applicants have amended Figure 3 to illustrate that the output of the prefilter 56 is fed into the DFSE 58 and an output line from the DFSE 58. As further recommended in the Office Action, Applicants have provided separate replacement sheets for the drawings for Figures 2 and 3.

Therefore, Applicants respectfully request withdrawal of the objections to the drawings. Applicants respectfully submit that the drawings are now in condition for issuance.

(B) ***Objections to the Claims***

The Office Action objected to claims 26, 28, and 36 because of minor informalities. In particular, the Office Action alleged that in claim 26 "signal filter" should be replaced with "prefilter" to be consistent with claim 21. The Office Action alleged that in claim 28 redundant limitations should be omitted. The Office Action also alleged that in claim 36, at lines 2 and 3, clarification should be made as to whether the limitation "the forming" refers to "the forming optimized feedforward filter parameters" and/or "the forming optimized feedback filter parameters."

Accordingly, Applicants have amended claims 26, 28, and 36 to more particularly point out and distinctly claim the subject matter of the invention, as recommended in the Office Action.

Therefore, Applicants respectfully request withdrawal of the objections of claims 26, 28, and 36. Applicants respectfully submit that claims 26, 28, and 36 are in condition for allowance.

(C) ***Claim Rejections under 35 U.S.C. §103(a)***

The Office Action rejected claims 21, 23-26, 28, 30-33, 36, 38, 40-42, 46, and 47 under 35 U.S.C. §103(a) as being allegedly unpatentable over Zangi in view of Ketchum. The Office Action alleged that Zangi discloses every element recited in the pending claims with the exception of a multiple-input, multiple-output (MIMO) system having a plurality of signal receivers where concurrent interference and prefilter operation can be performed for a plurality of signals received through the signal receivers. The Office Action alleged that Ketchum cures the deficiencies of Zangi. Applicants respectfully submit that the claims recite subject matter that is neither described nor suggested in a combination of Zangi and Ketchum.

Claim 21, upon which claims 23-28, 30-31, and 46-47 depend, recites an apparatus. The apparatus includes a signal filter configured to filter a signal from a signal receiver of a multiple-input, multiple-output system, and a signal estimator configured to estimate channel operations of the signal from the signal filter. The apparatus also includes a signal optimizer configured to generate optimized values for the signal from the signal filter, a prefilter configured to filter the signal from the signal filter using the generated optimized values for the signal, and a decision feedback sequence estimator configured to receive the generated optimized values. The decision feedback sequence

estimator includes a summing element, a feedback filter, and a maximum likelihood sequence estimator. The summing element, the feedback filter, and the maximum likelihood sequence estimator are operatively connected to one another and further operatively connected to the prefilter. An interconnection of the prefilter, the feedback filter, the maximum likelihood sequence estimator, and the summing element in the apparatus is configured to permit concurrent interference and prefilter operations to be performed for a plurality of signals received by a plurality of signal receivers in the multiple-input, multiple-output system.

Claim 32, upon which claims 33, 36, and 37 depend, recites a method. The method includes receiving a data vector at a receiving station of a multiple-input, multiple-output system, forming optimized feed forward filter parameters from the data vector, and forming optimized feedback filter parameters from the data vector. The method further includes transmitting the optimized feed forward filter parameters and the optimized feedback filter parameters to a decision feedback sequence estimator. The decision feedback sequence estimator includes a feedback filter. Further, the method includes applying the optimized feed forward filter parameters to a feed forward filter to define filter characteristics of the feed forward filter, and applying the optimized feedback filter parameters to the feedback filter to define filter characteristics of the feedback filter. The method also includes simultaneously performing interference cancellation and pre-filtering operations on the data vector through operation of the feed forward and feedback filters. Receiving the data vector includes receiving a plurality of

data vectors on a corresponding plurality of receiving chains at the receiving station of the multiple-input, multiple-output system.

Claim 38, upon which claims 40-42 depend, recites an apparatus. The apparatus includes signal filtering means for filtering a signal from a signal receiver of a multiple-input, multiple-output system, and signal estimating means for estimating channel operations of the signal from the signal filter means. The apparatus also includes signal optimizing means for generating optimized values for the signal from the signal filtering means, prefiltering means for filtering the signal from the signal filtering means using the generated optimized values for the signal and interference cancelling means for receiving the generated optimized values to perform concurrent interference and prefilter operations. The interference cancelling means includes pre-filtering means, summing means for summing inputs from the prefilter means, feedback filtering means for filtering optimized values and a summed output from the signal optimizing means and the summing means, respectively, and maximum likelihood sequence estimating means for generating maximum-likelihood values from the summing means. An interconnection of the pre-filtering means, the feedback filtering means, the maximum likelihood sequence estimating means, and the summing means in the apparatus is configured to permit the concurrent interference and prefilter operations to be performed for a plurality of signals received by a plurality of signal receivers in the multiple-input, multiple-output system.

Applicants respectfully submit that certain embodiments of the invention provide non-obvious advantages. Specifically, certain embodiments of the invention relate to a

MIMO communication system, whereby interference cancellation and equalization pre-filtering operations at a receiving station of the MIMO communication system are performed. Hence, the system includes a joint encoder, a MIMO transmission, and a MIMO receiver.

As will be discussed below, a combination of Zangi and Ketchum fails to disclose or suggest every element recited in claims 21, 23-26, 28, 30-33, 36, 38, 40-42, 46, and 47, and therefore fails to provide the advantages and the features of the claims discussed above.

Zangi is directed to a method for computing a coefficient of a finite impulse response pre-filter applied prior to a decision algorithm in an equalizer having adjustable filter coefficients. Computations performed to compute the filter coefficients for a right half burst may be used to compute the prefilter for a left hand burst, reducing the number of computations. A square root-free algorithm may be used to solve the system of linear equations, reducing computational complexity (Zangi, col. 2, lines 8-39).

Ketchum is directed to a time-domain transmit and receive processing with channel eigenmode decomposition for MIMO systems. Ketchum discusses techniques for processing a data transmission at a transmitter and receiver. A time-domain implementation is provided in Ketchum that uses frequency-domain singular value decomposition and "water-pouring" results to derive time-domain pulse-shaping and beam-steering solutions at the transmitter and receiver. The singular value decomposition is performed at the transmitter to determine eigenmodes (*e.g.*, spatial

subchannels) of a MIMO channel and to derive a first set of steering vectors used to "precondition" the received signals so that orthogonal symbol streams are recovered at the receiver. Water-pouring analysis is used to more optimally allocate the total available transmit power to the eigenmodes, which then determines the data rate and the coding and modulation scheme to be used for each eigenmode (Ketchum, col. 2, line 25, to col. 3, line 10).

As discussed in Applicants' Response dated December 30, 2009, Zangi fails to disclose or suggest, at least, "a signal filter configured to filter a signal from a signal receiver of a multiple-input, multiple-output system" and "wherein an interconnection of the prefilter, the feedback filter, the maximum likelihood sequence estimator, and the summing element in the apparatus is configured to permit concurrent interference and prefilter operations to be performed for a plurality of signals received by a plurality of signal receivers in the multiple-input, multiple-output system," as recited in claim 21 (emphasis added), and similarly recited in claims 32 and 38.

Zangi fails to mention either feature associated with a multiple-input, multiple-output system. Zangi is specifically related to a system including a single transmitter and a single receiver.

Furthermore, contrary to the Office Action's allegations, Zangi also fails to describe "a decision feedback sequence estimator configured to receive the generated optimized values, wherein the decision feedback sequence estimator comprises a

summing element, a feedback filter, and a maximum likelihood sequence estimator," as recited in claim 21 (emphasis added), and similarly recited in claims 32 and 38.

The Office Action grouped the feedback filter 104, the summer 106, and the decision algorithm 108 described in Zangi to allege that Zangi describes the "decision feedback sequence estimator" recited in the pending claims (*see* Office Action, page 5, "circuits (104, 106, and 108) [are] considered as the claimed "decision feedback sequence estimator" to receive the coefficients (optimized values), note input to filter 104). However, a review of Zangi demonstrates that Zangi fails to disclose or suggest every element recited in the pending claims.

Zangi explicitly describes an equalizer 100, which may be a decision feedback equalizer (DFE) or a decision feedback sequence estimation (DFSE) equalizer. Equalizer 100 includes an equalization filter 101, *a decision algorithm 108*, and a processor 120. Equalization filter 101 includes a prefilter 102, *a feedback filter 104*, and *a summer 106*. Processor 120 includes a channel estimator 122 and an adaptive algorithm 124 (Zangi, Figures 1 and 3; col. 3, line 29, to col. 4, line 60). Thus, equalizer 100, which Zangi explicitly describes as a DFSE, includes a feedback filter 104, a summer 106, and a decision algorithm 108, *i.e.*, all three structural elements are contained within the DFSE 100 (*see* Zangi, Figure 3).

Zangi further explicitly describes that DFSE 100 includes the pre-filter 102, the channel estimator 122, and the adaptive algorithm 124, *i.e.*, the pre-filter 102, the channel estimator 122, and the adaptive algorithm 124 are also contained within the DFSE 100.

Accordingly, one of ordinary skill in the relevant art would have understood that the DFSE 100 is not "configured to receive the generated optimized values" (emphasis added), rather, the optimized values are generated within the DFSE 100. DFSE 100 only receives the "received sequence, *r(k)*."

Applicants respectfully submit that the Office Action improperly re-grouped the elements of the DFSE 100, as described in Zangi, to exclude the processor 120, so that the "optimized values" generated within the adaptive algorithm 124 could be received within the newly grouped DFSE (only including the feedback filter 104, the summer 106, and the decision algorithm 108). As previously noted, Zangi explicitly describes that the DFSE includes the processor 120, the channel estimator 122, and the adaptive algorithm 124, and therefore the optimized values are generated within the DFSE 100, not received by the DFSE 100.

Accordingly, Zangi fails to describe or suggest, at least, "a decision feedback sequence estimator configured to receive the generated optimized values, wherein the decision feedback sequence estimator comprises a summing element, a feedback filter, and a maximum likelihood sequence estimator," as recited in claim 21 (emphasis added), and similarly recited in claims 32 and 38.

Applicants respectfully submit that one of ordinary skill in the relevant art would not have found it obvious to combine Zangi with Ketchum. The Office Action alleged that it would have been obvious to combine Zangi and Ketchum to improve signal detection since the system would have been able to be configured to receive multiple

copies so that existence of signal error can be easily determined (*see* Office Action on page 6). Applicants respectfully disagree with the allegations presented in the Office Action.

One of ordinary skill in the relevant art would have understood that the fundamental differences between the features for the system discussed in Ketchum and the features of the system discussed in Zangi would have made it non-obvious to combine Zangi and Ketchum. For example, Ketchum discusses applying singular value decomposition (SVD) to derive time-domain *pulse-shaping* and *beam steering* solutions at a transmitter. Additionally, Ketchum discusses the application of the SVD at the receiver to restore orthogonality (*see*, for example, the abstract of Ketchum) of the orthogonal symbol streams. Embodiments of the invention are not directed, nor require, *pulse-shaping*, *beam steering*, or orthogonal symbol streams. One would have concluded that these fundamental differences between Zangi and Ketchum demonstrate that a combination of Zangi and Ketchum would not have been obvious. Furthermore, one of ordinary skill in the relevant art would have understood that such a combination of Zangi and Ketchum would render Zangi unsatisfactory for its intended purpose.

Assuming *arguendo*, however, that Zangi could be combined with Ketchum, the combination of Zangi and Ketchum fails to disclose or suggest, at least, "a decision feedback sequence estimator configured to receive the generated optimized values, wherein the decision feedback sequence estimator comprises a summing element, a feedback filter, and a maximum likelihood sequence estimator" and "a decision feedback

sequence estimator configured to receive the generated optimized values, wherein the decision feedback sequence estimator comprises a summing element, a feedback filter, and a maximum likelihood sequence estimator," as recited in claim 21 (emphasis added), and similarly recited in claims 32 and 38. Thus, assuming *arguendo* that Zangi could be combined with Ketchum, the combination of Zangi and Ketchum fails to disclose or suggest every element recited in claims 21, 32, and 38.

Therefore, Applicants respectfully request withdrawal of the rejections of claims 21, 23-26, 28, 30-33, 36, 38, 40-42, 46, and 47 under 35 U.S.C. §103(a). Applicants respectfully submit that claims 21, 32, and 38, and the claims that depend therefrom, are in condition for allowance.

The Office Action rejected claims 27 and 37 under 35 U.S.C. §103(a) as being allegedly unpatentable over Zangi in view of Ketchum, and further in view of Taylor. The Office Action alleged that the combination of Zangi and Ketchum discloses every element recited in independent claims 21 and 32. The Office Action referred Taylor to disclose the elements recited in dependent claims 27 and 37. Applicants respectfully submit that the claims recite subject matter that is neither described nor suggested in a combination of Zangi, Ketchum, and Taylor.

Zangi and Ketchum were discussed above. Taylor is directed to a transparent data transmission for a wireless/cellular communication system. An analog signal from a modem or other source is converted at a remote station to a digital bit stream in

accordance with a memoryless compaction rule. The resultant bit stream is then transmitted through a transparent channel that includes a wireless cellular-telephone link. At the base station, that bit stream is transmitted over a public-switched-network span (Taylor, paragraphs [0003]-[0005]).

As previously noted, one of ordinary skill in the relevant art would not have found it obvious to combine Zangi and Ketchum. Assuming *arguendo*, however, that Zangi could be combine with Ketchu, the combination of Zangi and Ketchum fails to disclose or suggest every element recited in claims 21 and 32. Taylor fails to cure the deficiencies of Zangi and Ketchum. Specifically, Taylor fails to disclose or suggest, at least, "a signal filter configured to filter a signal from a signal receiver of a multiple-input, multiple-output system" and "wherein an interconnection of the prefilter, the feedback filter, the maximum likelihood sequence estimator, and the summing element in the apparatus is configured to permit concurrent interference and prefilter operations to be performed for a plurality of signals received by a plurality of signal receivers in the multiple-input, multiple-output system," "a decision feedback sequence estimator configured to receive the generated optimized values, wherein the decision feedback sequence estimator comprises a summing element, a feedback filter, and a maximum likelihood sequence estimator" and "a decision feedback sequence estimator configured to receive the generated optimized values, wherein the decision feedback sequence estimator comprises a summing element, a feedback filter, and a maximum likelihood sequence estimator," as recited in claim 21 (emphasis added), and similarly recited in claim 32. Accordingly, the

assuming *arguendo* that Zangi could be combined with Ketchum and Taylor, the combination of Zangi, Ketchum, and Taylor fails to disclose or suggest every element recited in claims 21 and 32.

Claims 27 and 37 depend from claims 21 and 32, respectively. Accordingly, claims 27 and 37 should be allowable for at least their dependency upon an allowable base claim, and for the specific limitations recited therein.

Therefore, Applicants respectfully request withdrawal of the rejections of claims 27 and 37 under 35 U.S.C. §103(a). Applicants respectfully submit that claims 21 and 32, and the claims that depend therefrom, are in condition for allowance.

II. CONCLUSION

In conclusion, Applicant respectfully submits that each of Zangi, Ketchum and Taylor, whether taken individually or in combination, fails to describe or suggest each and every feature recited in claims. The distinctions previously noted are more than sufficient to render the claimed invention non-obvious. It is therefore respectfully requested that all of claims be allowed, and this present application be passed to issuance.

If for any reason the Examiner determines that the application is not now in condition for allowance, it is respectfully requested that the Examiner contact, by telephone, Applicants' undersigned representative at the indicated telephone number to arrange for an interview to expedite the disposition of this application.

In the event this paper is not being timely filed, Applicants respectfully petition for an appropriate extension of time. Any fees for such an extension together with any additional fees may be charged to Counsel's Deposit Account 50-2222.

Respectfully submitted,

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Enclosures: Replacement Sheets for Figures 2 and 3